5.3 The NIST Advanced Technology Program: Materials Processing for Heavy Manufacturing

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Abstract

The NIST Advanced Technology Program (ATP) is a unique partnership between government and private industry to accelerate the development of high-risk technologies that promise significant commercial payoffs and widespread benefits for the economy. The ATP enables industry to pursue promising technologies that otherwise would be ignored or developed too slowly to compete in rapidly changing world markets. In the highly competitive, fast-moving international marketplace, the ATP creates opportunity. This presentation will contain an overview of the ATP followed by a review of one of the current focused programs: "Materials Processing for Heavy Manufacturing." This program targets projects specifically in the areas of advanced metals and ceramics, along with their composites. The goal is to develop and demonstrate innovative materials processing technologies which enable product differentiation (durability, reliability, and efficiency) and manufacturing cost reduction (elimination of process steps, elimination of waste, and reduction in manufacturing cycle time). The presentation will introduce the current projects, with a concentration on the stationary power generation market.

Materials Processing for Heavy Manufacturing

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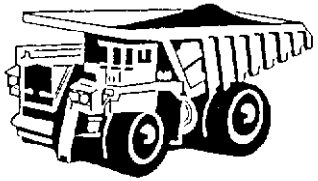
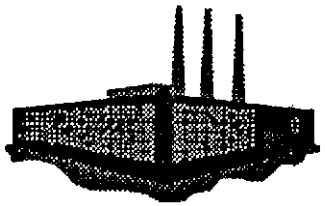
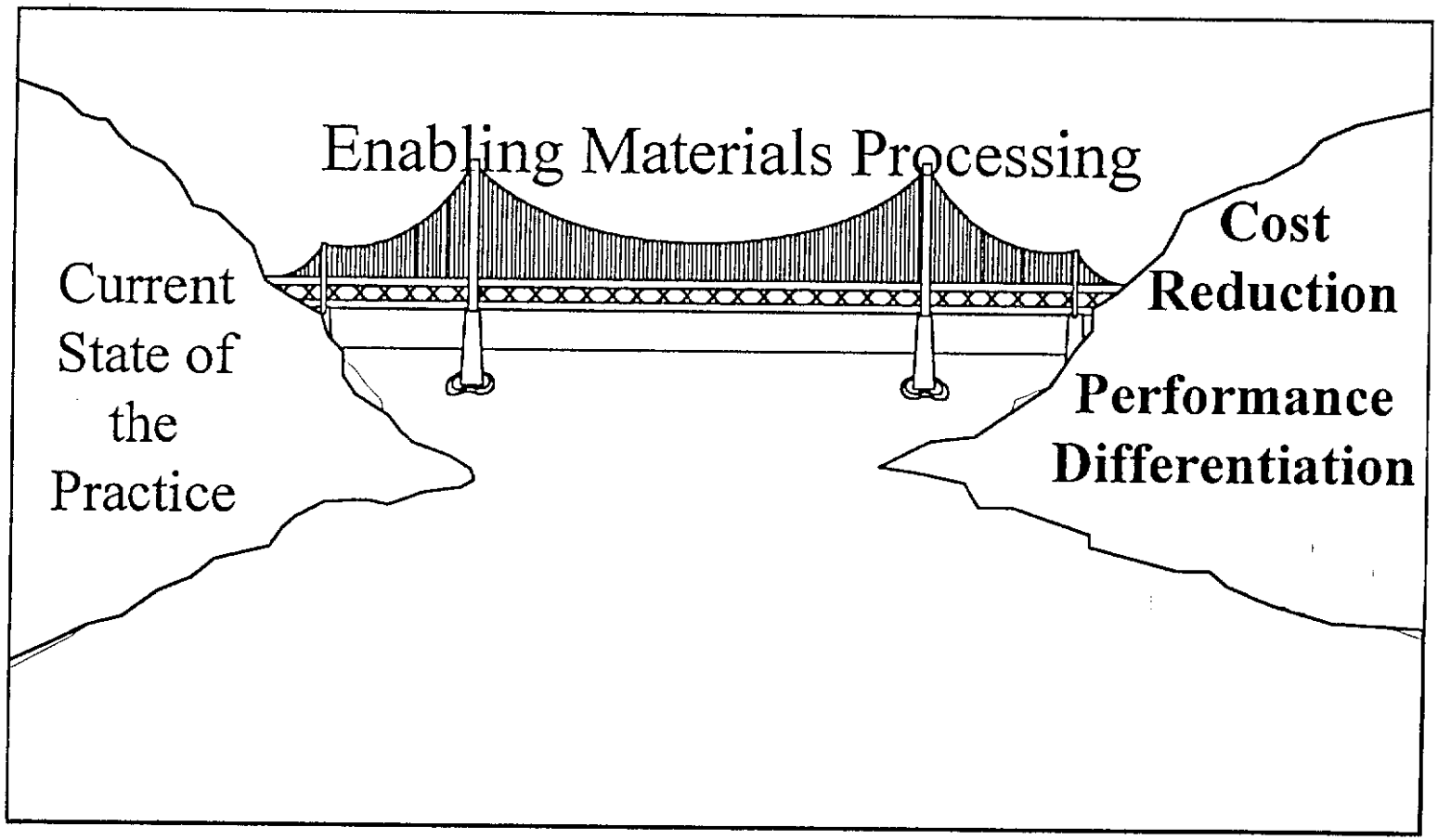
Common Technical Issues



High temp structures
Oxidative environments
Combustion efficiency
Frictional losses
Wear
Large production volumes / yields
Component uniformity / reproducibility
Process robustness / flexibility
High loading



Materials Processing for Heavy Manufacturing



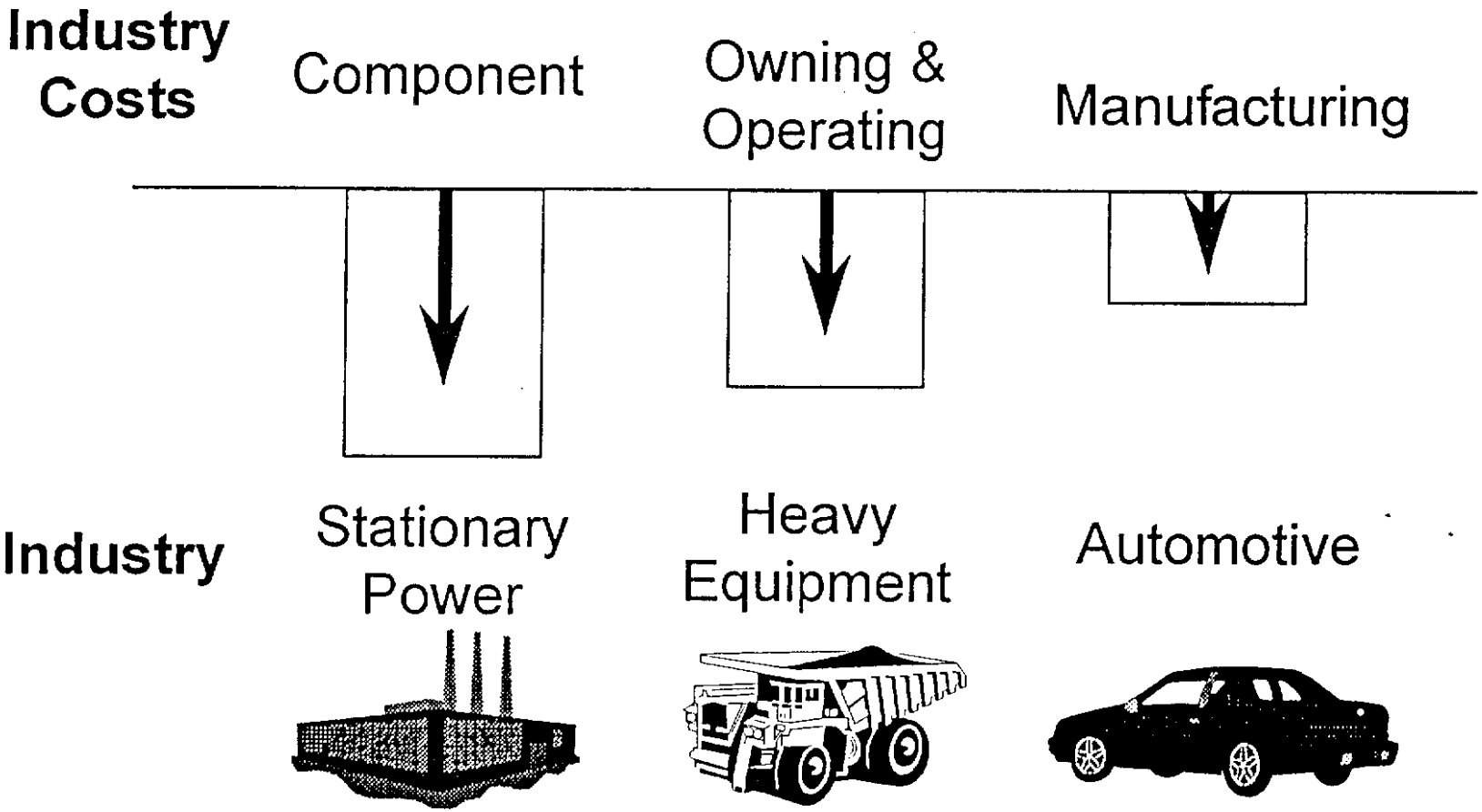
Program Technical Goals

Develop and demonstrate innovative and enabling materials processing technologies leading to:

- Product differentiation through Performance
  - » Durability
  - » Reliability
  - » Efficiency
- Manufacturing cost reduction
  - » Process steps
  - » Waste
  - » Manufacturing cycle time

Business Goals: Cost Reduction

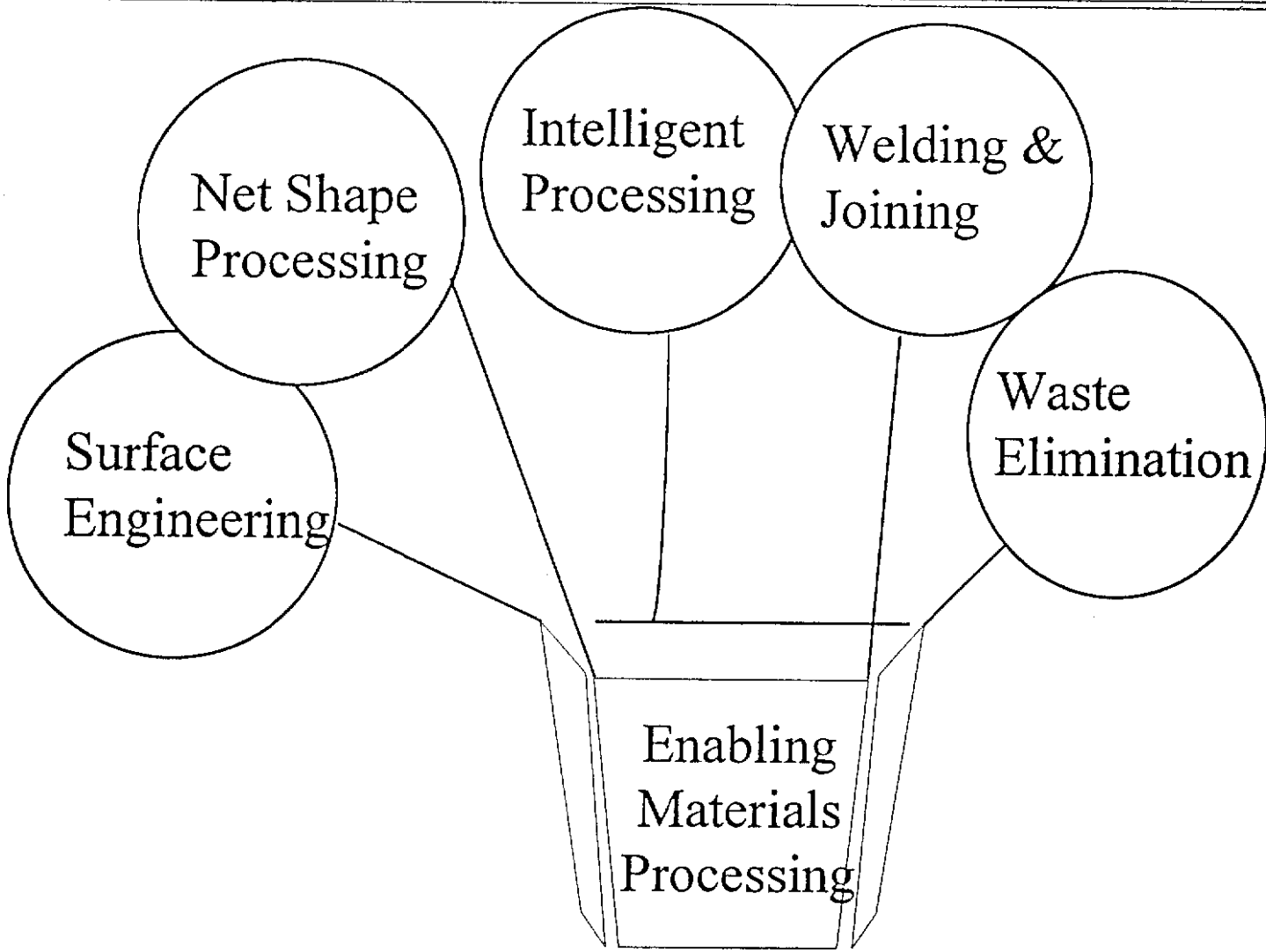
U.S. Value Leadership for Products of Heavy Manufacturing



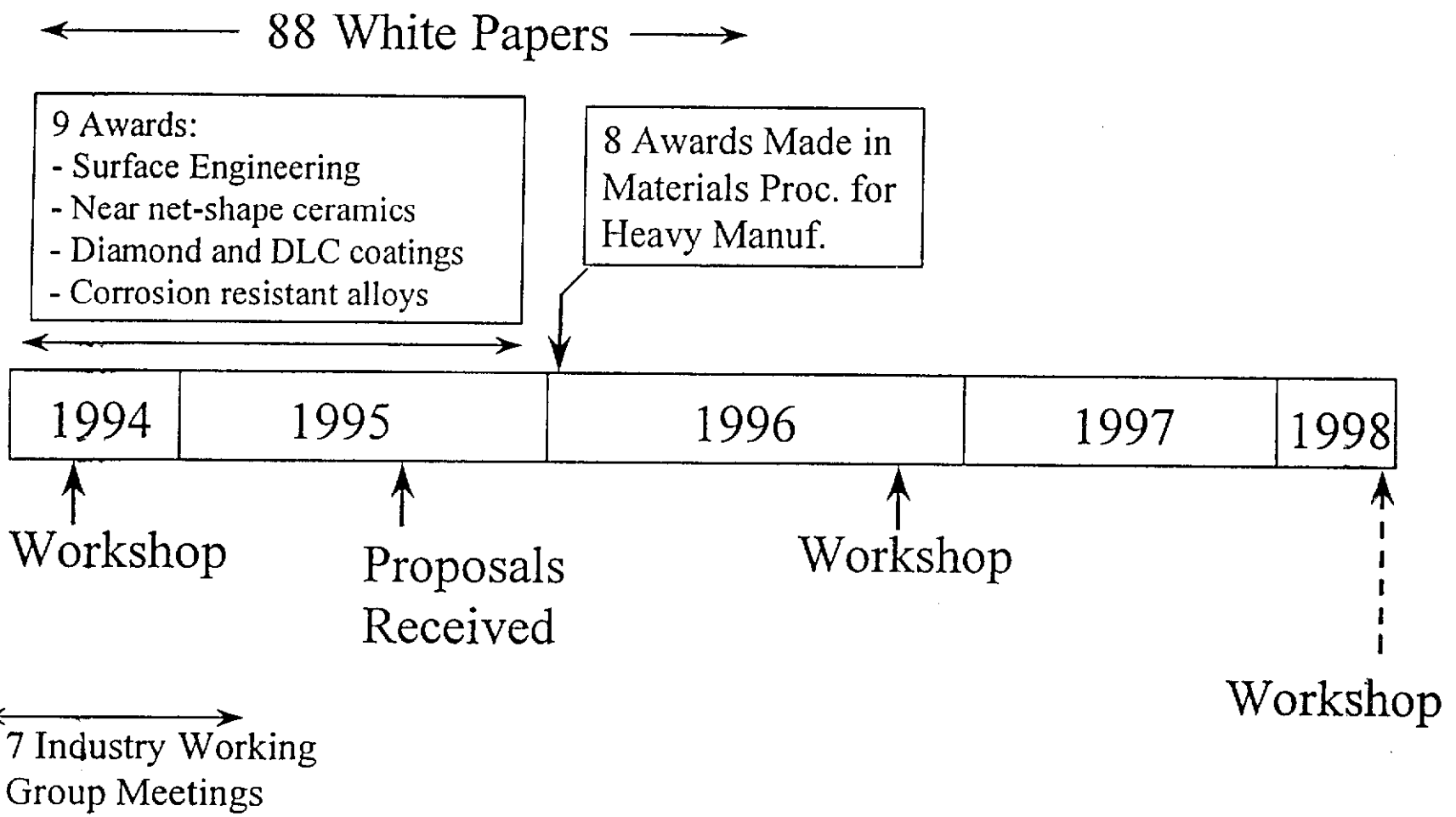
Why ATP?

- Materials are at the base of the food chain
- Technical barriers to new opportunities include:
  - » Combustion efficiency
  - » Frictional losses
  - » Wear
  - » Production yields
  - » Material and component uniformity
  - » Acceptance by designers / customers
- Success will result in
  - » Cost reduction
  - » Performance increases

95-07 Solicitation Strategy



How did this program evolve?



Materials Processing for Heavy Manufacturing

Surface Technologies

Functionally Gradient Materials

•Caterpillar — Transmissions, gear boxes

Engineered Surfaces

•Caterpillar/Timken/GM Gear — Bearings, gears, Fuel injection components

Linear Magnetron Sputtering

•Praxair — Hydraulic cylinders, other internal cylindrical surfaces

Chemical Vapor Deposition

•Crystallume/Rogers Tool Works/Hughes/GM/Boeing/Ford — Rotating Cutting Tools

Intelligent Processing

•GE — Thermal barrier coatings for Turbine blades

Welding and Joining

Welding/Intelligent Processing

•Caterpillar/Lincoln Electric/AO Smith/US Steel — Fabricated Structures

Net/Near-Net Shape Processing

Die Casting

•AlliedSignal/Top Die/Stahl — Al automotive parts

Permanent Mold Casting

•AlliedSignal/Top Die/Stahl — Al automotive parts

Investment/Sand Casting

•Precision Castparts — Engine Exhaust Frames

Casting/Liquid Phase Bonding

•Westinghouse/PCC — Segmented Turbine Blades

Forging

•Wyman-Gordon — Turbine Disks

Gel Casting

•AlliedSignal — Turbocharger Rotors

Aqueous Injection Molding

•AlliedSignal — Turbine Blades

Stationary Power Generation

- Turbine blades
  - » GE: Intelligent processing
  - » Westinghouse/PCC: Transient liquid phase bonding
  - » AlliedSignal: Silicon Nitride ceramics
- Turbine disks
  - » Wyman-Gordon: Advanced forging
- Exhaust frames
  - » PCC: Investment casting

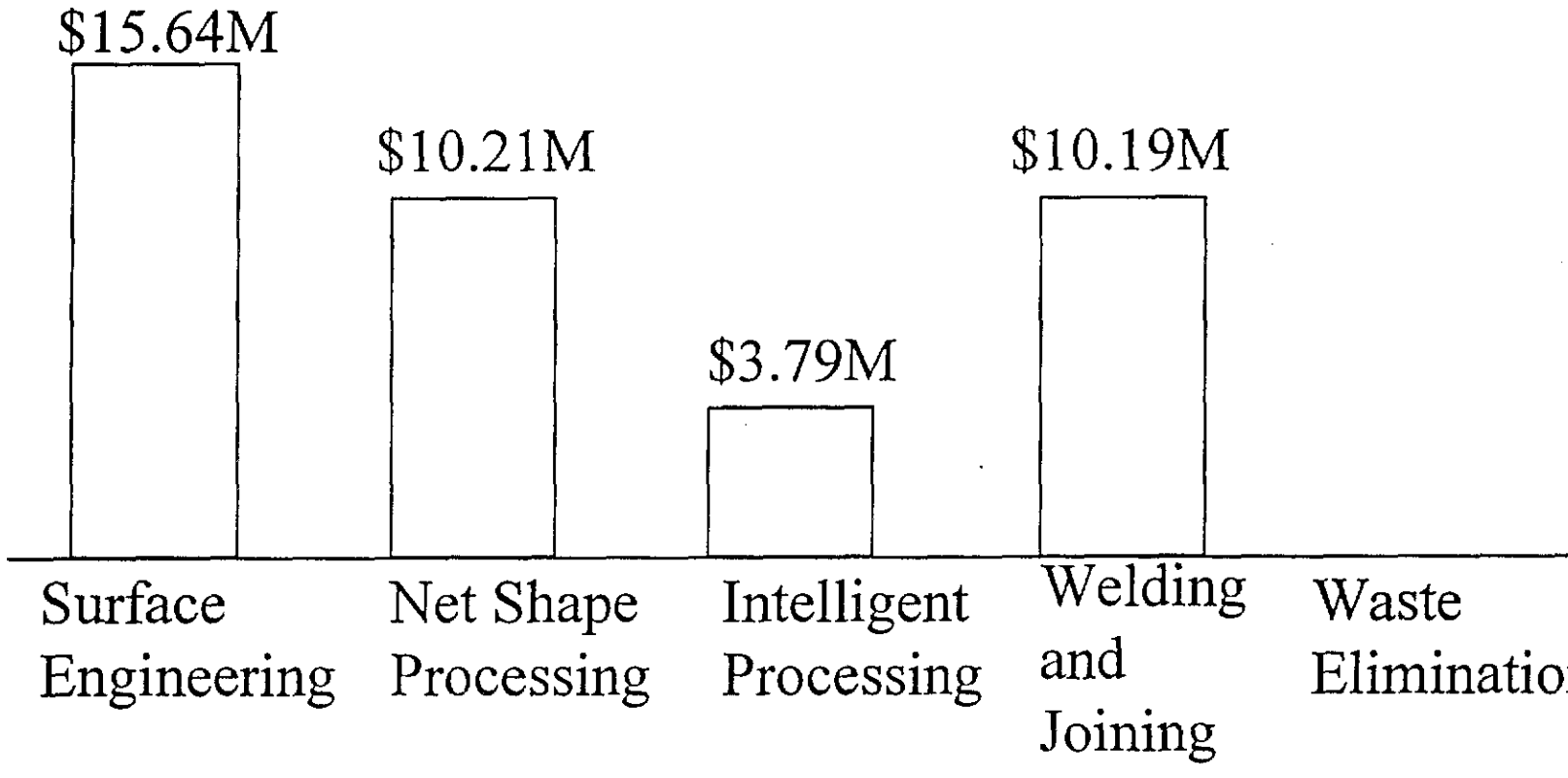
NIST Intramural Projects

- Surface Chemistry in Aqueous Processing of Silicon Nitride Powder
- Development of Porosity in Al Die Castings
- Indentation Testing of Coatings
- Weld Sensing and Control
- Intergranular Eta Phase and its effect on LCF of 706 Forgings

Where are we today?

- 17 projects / 65+ participating organizations
- Turbine technology
- Surface engineering
  - » Cross-cuts markets
- Process optimization
  - » Move from empirical towards structure
- Cooperation of suppliers, processors, OEM's to overcome large barriers
- Simultaneous goals of cost reduction and performance differentiation
- Vertical integration

Current Research



Total ATP Investment	$39.8M
Industry Match	$38.7M
Total Research	$78.5M

Evidence of Continued Industry Commitment

- General competition submissions
- Industry roadmaps in aluminum, metal casting, steel
- Participation/support in 1996 National Meeting
- Technical barriers still exist

Related Federal Activities

- DOE
  - » Industries of the Future
  - » Advanced Turbine Systems
- DARPA
  - » Ceramic Insertion Program
- NSF
- DOD

Teaming Opportunities

Vertical Integration

- OEM
- Component Manufacturers
- Equipment Manufacturers
- Materials Processors
- Materials Producers

Horizontal Integration

Shared Technology Needs

- Surface Engineering
- Intelligent Processing of Mat.
- Net Shape Forming
- Welding and Joining
- Waste Elimination

Challenges for the Future

- Technology focus
- Greater involvement of
  - » Small companies and universities
  - » Automotive sector
- Increased number of JV's
- Heavy Equipment
  - » Expand to oil and gas, mining, farm...
- Technology diffusion

Strategy

- Industry engagement
- Future workshop(s)/National Meeting
- Involve MEP in outreach and diffusion
- Increase association involvement
- Linking to DOE/OIT roadmapping activities
- Working group meetings
- Conference involvement
- Trade journal articles, calendars

Current and Future Activity

- Interaction with industry
  - » September 1996 Workshop
    - – 106 participants, including current awardees and potential applicants
    - – Technical progress of current projects shared
  - » Future workshop
- Strategic planning
  - » Continued solicitations for white papers
  - » Working groups to follow
  - » Scope modifications as appropriate

Technology Flow and Market Linkage